PATENT SPECIFICATION

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(19)

(54) IMPROVEMENTS IN OR RELATING TO DYNAMO ELECTRIC MACHINES

(71) We, THE ENGLISH ELECTRIC COMPANY LIMITED, of 1, Stanhope Gate, London, W1A 1EH, a British Company, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to dynamo-electric machines of the kind having a rotor winding comprising a plurality of electrical conductors accommodated in axially extending slots in the rotor core, and held in position by wedges engageable with co-operating retaining surfaces of the core at the mouths of the slots, the invention being especially, but not exclusively, concerned with large alternating current electrical generators.

In operation of such generators unbalanced loading conditions and faults on the stator winding can cause zero sequence and negative sequence currents to be generated in the rotor. These currents principally flow in the rotor surface namely the pole face, the rotor teeth formed between the rotor slots, and the wedges.

Commonly a plurality of wedges of non-magnetic electrically conductive material are disposed end to end in each rotor slot, and since the currents produced under unbalanced loading or fault conditions flow axially in the wedges there is a tendency, at the gaps between adjacent wedges, for current to pass from an end of one wedge to the adjacent rotor teeth and back to the next wedge. This has been found to produce regions of high current density in the teeth adjacent the wedge gaps, leading to a local rise in temperature at those regions, which can in some cases be excessive.

One known way of reducing this effect is to fit, what are generally termed damper windings, between the wedges and an insulating layer formed between the wedges and the outermost rotor conductors, the damper windings, which are usually of copper, providing a current path in parallel with the teeth between adjacent wedges.

However this has the disadvantage that the damper windings occupy space within the conductor slots which could more usefully be occupied by rotor winding conductors and an object of the present invention is to provide an alternative way of dealing with the problem.

According, therefore, to the invention in a dynamo-electric machine of the kind referred to, in which the rotor conductors in each slot are held in position by a plurality of electrically conductive wedges disposed end to end in the slot and engageable with co-operating retaining surfaces at the mouth of the slot, immediately adjacent wedges in each slot have their adjacent ends shaped to provide opposed recesses, and a respective electrically conductive member is located between each pair of said adjacent wedges so as to be accommodated partly within each of the corresponding opposed recesses and to be pressed into contact-making engagement with co-operating surfaces of the corresponding pair of wedges, at least during operation of the machine, thereby to provide an electrically conductive path between them.

The electrically conductive members, by providing a continuous current path between the wedges, ensure the flow of currents into and from the rotor teeth at the ends of the wedges, and the consequent formation of regions of high current density leading to excessive temperature rises, is effectively prevented, without reducing the slot space, as is the case in machines employing a damper winding interposed between the wedges and the adjacent insulating layer.

The shapes and dimensions of the re-

cesses and each associated conductive member may be such that the later is pressed into engagement with the co-operating surfaces of the wedges under centrifugal force when the dynamo-electric machine is operating, although in some cases the required contact pressure between the conductive member and the wedges can be achieved by compression of the member during the fitting of the wedges into the slots.

The radially inward faces of each said pair of immediately adjacent wedges in each slot may be shaped by chamfering or cutting away at their adjacent ends so that the recesses are formed between surfaces of the wedges and an insulating strip interposed between the wedges and the radially outermost conductors.

Alternatively the recesses may be provided by slots or grooves formed in the adjacent ends of each said pair of immediately adjacent wedges.

A number of different embodiments of the invention will now be described by way of example with reference to Figures 1 to 7 of the accompanying schematic drawings, in which:—

Figure 1 illustrates, in diagrammatic form, part of a transverse section through the rotor of a large turbo-driven alternator having the rotor windings held in position within slots in the rotor core by means of wedges.

Figure 2 represents a plan view of a short length of one of the rotor slots of Figure 1,

Figure 3 represents a longitudinal section through part of a rotor slot illustrating one embodiment of the invention, and

Figures 4 to 7 illustrate alternative embodiments of the invention.

Referring first to Figures 1 and 2, the alternator rotor 1 comprises a solid cylindrical ferro-magnetic core 2 having formed in its periphery a plurality of deep axially extending slots 3.

The rotor carries a magnetising winding incorporating copper conductors 4 accommodated within the slots as shown, the conductors being electrically insulated from each other and from the slot walls and being formed with channels 5, both longitudinally and radially, for the passage of a cooling fluid, such as hydrogen.

The conductors 4 are secured in the slots 3 by slot wedges 6 which are keyed at med in the sides of the slots near their mouths, so that the wedges close the mouths of the slots and hold the conductors in position in the slots. The wedges 6 are formed of non-magnetic electrically conducting material, such as an austenitic stainless steel, and are separated from the outermost conductors by electrically insulating strips 8 in known manner, also being provided with radial channels as at 20 for the passage of the cooling fluid between the rotor surface and the rotor interior.

Currents generated in the rotor surface under conditions of unbalanced loading, or due to faults on the stator winding, flow principally in an axial direction, and unless means are provided to prevent it, current flows from one wedge to the next via the rotor teeth 9 as indicated by the broken lines 10 in Figure 2, this producing regions of high current density with the consequent risk of overheating.

This is avoided, in accordance with the present invention, by shaping the adjacent ends of pairs of immediately adjacent wedges 6 to form opposed recesses, and by locating a respective electrically conductive member between each pair of wedges so that part extends into each of the respective recesses, and is pressed into contact making engagement with co-operating surfaces of the wedges, at least during operation of the generator, and thereby forms an electrically conductive path between the wedges.

Thus, referring to Figure 3, the adjacent ends of the immediately adjacent wedges 6 in each slot 3 are chamfered on their radially inwardly facing surfaces, to form recesses between the chamfered surfaces 11 and the underlying insulating strip 8, each pair of adjacent recesses forming a triangular section space extending transversely across the slot 3 in which is accommodated a copper bar 12 of similar cross-section.

The bar 12 is shaped so that its outwardly facing surfaces are parallel to the chamfered surfaces 11 of the wedges 6, and in use of the generator the bar is pressed into good contact making engagement with the surfaces 11 by centrifugal force, thus providing an electrically conductive path directly between the wedges 6.

In the alternative embodiment shown in Figure 4 the ends of the wedges 6, instead of being chamfered, are formed with rectangularly sectioned recesses 13, and the triangular bar of Figure 3 is replaced by a rectangular bar 14 which, in use of the generator, is pressed into engagement with the radially inwardly facing surfaces 15 of the recesses 13 by centrifugal force to provide a conducting path between the wedges.

A somewhat similar arrangement, utilising a rectangular bar 14 is illustrated in Figure 5, although in this case the adjacent ends of the wedges 6 are formed with rectangular sectioned slots 16 which accommodate the bars 14, the bars being pressed into engagement with the outer surfaces 17

of the slots to provide a good electrical contact with the wedges 6 under centrifugal force when the alternator is operated.

Figure 6 illustrates an arrangement in which the ends of the wedges 6 are chamfered, as in Figure 3, but in this case the triangular sectioned copper bar of the earlier embodiment is replaced by a circular copper bar 18 which is pressed into engagement with the chamfered surfaces 11 of the wedges duirng the fitting of the wedges into the slots 3.

Another embodiment in which circular copper bars 18 are pressed into engagement with co-operating surfaces at the ends of adjacent wedges 6 is illustrated in Figure 7. In this case however the ends of the wedges are formed with triangular sectioned grooves 19 which accommodate the bars 18.

However it will be appreciated that the embodiments described are by way of example only, and the recesses and the bars can have any other convenient shape and can be located at any desirable radial height in the wedges.

WHAT WE CLAIM IS:—

1. A dynamo-electric machine having a rotor winding comprising a plurality of electrical conductors accommodated in axially extending slots in a rotor core, the conductors in each slot being held in position by a plurality of electrically conductive wedges disposed end to end in the slot and engageable with co-operating retaining surfaces at the mouth of the slot, immediately adjacent wedges in each slot having their adjacent ends shaped to provide opposed recesses, and a respective electrically conductive memebr being located between each pair of said adjacent wedges so as to be accommodated partly within each of the corresponding opposed recesses and to be pressed into contact-making engagement with co-operating surfaces of the corresponding pair of wedges, at least during operation of the machine, thereby to provide an electrically conductive path between them.

2. A dynamo-electric machine as claimed in Claim 1, wherein the shapes and dimensions of the recesses and the associated conductive members are such that each conductive member is pressed into engagement with the co-operating surfaces of the respective wedges under centrifugal force when the dynamo-electric machine is operating.

3. A dynamo-electric machine as claimed in Claim 1, wherein the shapes and dimensions of the recesses and the associated conductive members are such that each conductive member is pressed into engagement with the co-operating surfaces of the respective wedges during the fitting of the wedges into the slots.

4. A dynamo-electric machine as claimed in any preceding claim, wherein the radially inward faces of each said pair of immediately adjacent wedges in each slot are shaped so that the recesses are formed between surfaces of the wedges and an electrically insulating strip interposed between the wedges and the radially outermost conductors.

5. A dynamo-electric machine as claimed in any one of Claims 1 to 3, wherein the recesses are provided by slots or grooves formed in the ends of the wedges.

6. A dynamo-electric machine as claimed in any preceding claim, wherein the opposed recesses of each said pair of immediately adjacent wedges together form a triangular section space extending transversely across the corresponding slot and each electrically conductive member is of triangular cross-section.

7. A dynamo-electric machine as claimed in any one of Claims 1 to 5, wherein the opposed recesses of each said pair of immediately adjacent wedges together form a triangular section space extending transversely across the corresponding slot and each electrically conductive member is of circular cross-section.

8. A dynamo-electric machine as claimed in Claim 6 or Claim 7, wherein the adjacent ends of each said pair of immediately adjacent wedges are chamfered on their radially inwardly facing surfaces to form the triangular section spaces.

9. A dynamo-electric machine as claimed in any one of Claims 1 to 5, wherein the opposed recesses of each said pair of immediately adjacent wedges together form a rectangular section space extending transversely across the corresponding slot and each electrically conductive member is of rectangular cross-section.

10. A dynamo-electric machine as claimed in Claim 9, wherein the adjacent ends of each said pair of immediately adjacent wedges are formed with rectangularly sectioned recesses in their radially inwardly facing surfaces to form the rectangular section spaces.

11. A dynamo-electric machine as claimed in Claim 9, wherein the adjacent ends of each said pair of immediately adjacent wedges are formed with rectangular sectioned slots in their facing surfaces to form the rectangular section spaces.

12. A dynamo-electric machine as claimed in any one of Claims 1 to 3, wherein the adjacent ends of each said pair of immediately adjacent wedges are formed with triangular sectioned grooves and each electrically conductive member is of cir-

cular cross-section.

13. A dynamo-electric machine having a rotor substantially as hereinbefore described with reference to Figures 1 to 3 of the accompanying drawings.

14. A dynamo-electric machine as claimed in Claim 13, modified substantially as hereinbefore described with reference to any one of Figures 4 to 7 of the accompanying drawings.

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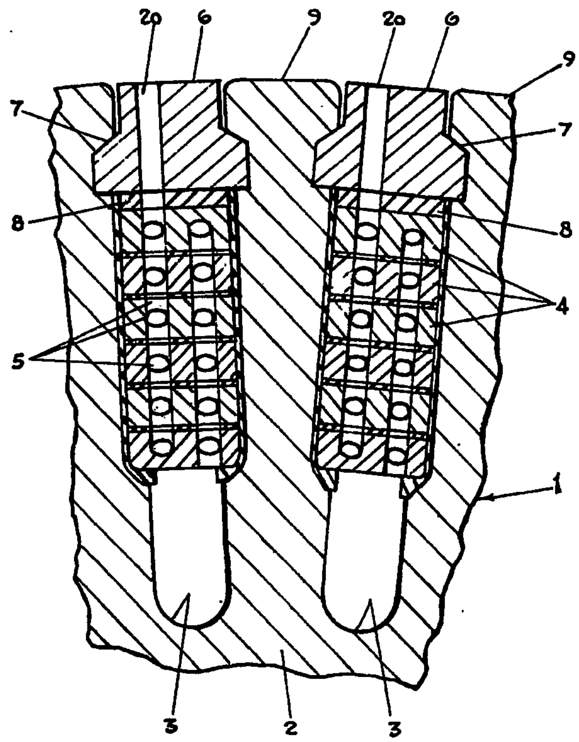

FIG. 1.

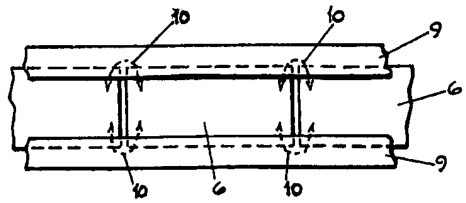

FIG. 2.

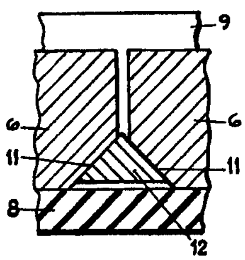

FIG. 3.

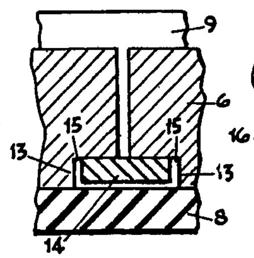

FIG. 4.

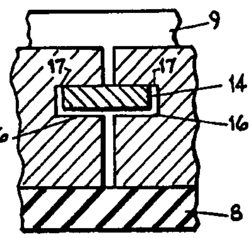

FIG. 5.

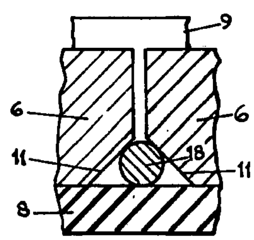

FIG. 6.

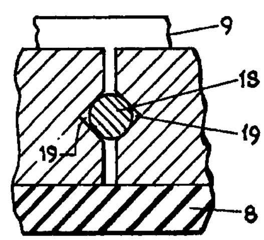

FIG. 7.